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BULLETIN OF THE
U.S. DEPARTMENT OF AGRICULTURE
No. 35

Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief.
December 31, 1913.

FACTORS GOVERNING THE SUCCESSFUL STORAGE OF CALIFORNIA TABLE GRAPES.[1]

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INTRODUCTION.

During the past seven years the Bureau of Plant Industry has been engaged in a study of the behavior of California table grapes in storage, the primary object for which the work was undertaken being the determination of the possibility of extending the territory over which these grapes may be distributed, as well as of lengthening their marketing season. Under existing conditions of storage, transportation, and marketing, the major portion of the California grape crop must be marketed within six weeks or two months after picking, and any great increase in output during such a limited season is likely to result in a glutted market and low prices. Present prospects indicate a large increase in production during the next 5 or 10 years; in fact, were the entire acreage in California now planted with table grapes to come into full bearing within the next five years it is estimated that the output would be nearly doubled. Table I shows the growth of the California table-grape industry during the past 11 years.

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[1] The investigations summarized in this paper were carried on during seven consecutive seasons, beginning in 1906. The work may be considered as an example of the successful demonstration and application under actual commercial conditions of principles and practices developed from careful observation and experimentation. The results in so far as the preliminary experimental phases of the work were concerned were ready for publication several years ago. It was felt, however, that unless an actual demonstration of the application of the principles under commercial shipping, storing, and marketing conditions could be accomplished under the supervision of the Departmental workers the industry would not accept or utilize the results in any effective way. The successful packing, storing, and marketing of grapes handled in accordance with the results of the work during two seasons give assurance that this system will become a permanent feature of the California table-grape industry. The important commercial test of 1912, comprising more than 30 carloads of fruit, was made possible by the consignments supplied by the following growers: A. H. Backer, Backer Bros. Vineyard, P. M. Baier, Steve Baker, Eisen Vineyard, Gunn Vineyard, Lines & Anderson, N. M. Miller, J. F. Putnam, Redbanks Orchard Co., G. C. Roeding, and M. M. Shooshan. Throughout the seven seasons during which the work was in progress, the successful prosecution of the experiments was largely due to the hearty cooperation afforded by a large number of growers of table grapes in California.—WM. A. TAYLOR, *Chief of Bureau.*

TABLE I.—*Shipments of fresh grapes from California, 1902 to 1912, inclusive.*[1]

Crop year.	Carloads.	Crop year.	Carloads.	Crop year.	Carloads.
1902	1,033	1906	2,052	1910	4,948
1903	1,804	1907	3,460	1911	6,375
1904	1,451	1908	3,816	1912	6,354½
1905	1,602	1909	5,875		

[1] Compiled from the annual numbers of the California Fruit Grower.

Much difficulty has been experienced in the past in transporting grapes over long distances and in holding them in sound condition long enough to get the benefit of the late holiday demand. As long as the present methods of picking and marketing table grapes remain unchanged the area over which the fruit can be distributed in sound condition is practically limited to its present dimensions. It is necessary, therefore, to find new markets within this area as outlets for the increasing production and to create a larger demand for this class of fruit, as well as to extend the area and lengthen the marketing season by improving the methods of handling and storing the grapes.

In addition to the great increase in the production of California table grapes, importations from Spain continue large. Table II[1] shows the quantity and value of Spanish grapes imported into the United States during the past seven years.

TABLE II.—*Imports of Spanish grapes into the United States during the fiscal years 1907 to 1913, inclusive.*

Fiscal year.	Cubic feet.	Barrels.[1]	Pounds.	Value.
1907	1,278,325	655,551	30,810,897	$1,531,352
1908	2,193,617	1,124,932	52,871,804	2,673,563
1909	1,145,748	587,563	27,615,461	1,473,095
1910	1,319,907	676,875	31,813,125	1,591,800
1911	1,448,420	742,779	34,910,613	1,637,281
1912	1,969,651	1,010,077	47,473,619	2,254,946
1913	1,104,799	566,564	26,628,518	1,285,203

[1] A barrel contains 1.95 cubic feet, the grapes weighing approximately 47 pounds.

The grapes produced in California are of the Vinifera or European type, differing materially from the American or native grapes grown in the eastern and central-western sections of this country. They are of the same general type as the "Almeria" or "Malaga" grapes imported from Spain, although the Almerian varieties are not as yet produced in commercial quantities in the United States. The Spanish grapes begin to arrive during the latter part of September, most of the shipments reaching this country during November; the fruit is then marketed throughout practically the entire winter, and to some extent during the spring months, although the heaviest demand is naturally during the holidays. The late varieties of California table grapes now compete principally with the first shipments of Almeria grapes, and any extension of their marketing season will necessarily mean increased competition with the imported fruit.

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[1] Compiled from the Annual Reports on Commerce and Navigation of the United States, Department of Commerce and Labor.

With the exception of small shipments sent to Boston, Baltimore, and one or two other places, all of the Spanish grapes are unloaded at New York and from there distributed throughout the country. The fruit is packed with a filler of ground cork and is shipped in barrels containing about 47 pounds net. Most of it arrives in cargo lots of 20,000 to 60,000 barrels, which are sold at auction a few days after arrival, being held in common storage until disposed of. Figure 1 shows the major portion of two cargoes of Spanish grapes stacked on a pier in New York. The fruit is bought by speculators, by fruit companies, and by agents representing retail dealers and fruiterers in various parts of the country. The cargoes are listed on auction sheets which give information regarding the brands and the quality and number of barrels of each brand offered. Certain brands which have a reputation for fine quality are in demand and generally realize high prices at auction. The quality of fruit in each lot is judged by the inspection of samples which are displayed during the sale, the number of barrels opened for inspection depending on the total number of barrels in each lot. These grapes are emptied on a table or platform elevator and are raised to the auction room, where the inspection and bidding usually consume only a few seconds. This fruit is later repacked and sold at a discount as "sample barrels."

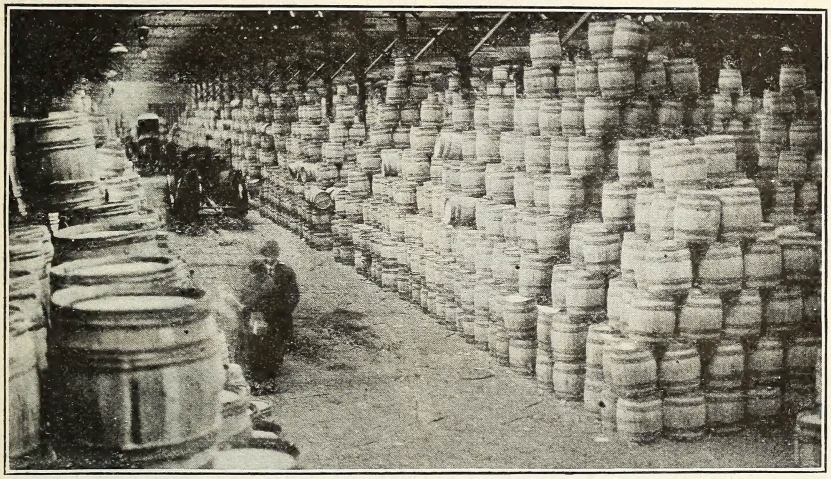


FIG. 1.—Imported Almeria grapes on the dock at New York. This shows the major portion of two cargoes aggregating 110,000 barrels.

Table III shows how wide was the range in the prices of the different grades of Spanish grapes sold at auction in New York during 1911–12 and 1912–13.

TABLE III.—*Range in prices of Spanish grapes sold at auction at New York during the seasons of 1911–12*[1] *and 1912–13.*[2]

Month.	Number of barrels.	Extra fancy and fancy.	Extra choice and choice.	Ordinary.	Poor.
1911.					
September	17,300	$2.87½–$4.62½	$1.75–$3.50	$1.25–$2.75	$0.25 –$1.75
October	203,000	3.50 – 6.00	2.50– 4.00	2.00– 2.87½	.75 – 2.87½
November	424,000	3.50 – 9.12½	2.50– 3.75	2.00– 2.75	.37½– 2.62½
December	144,000	3.75 – 8.50	2.50– 3.75	....	.62½– 2.50
1912.					
January	5,800	....	2.25– 4.25	....	.62½– 2.25
	794,100	2.87½– 9.12½	1.75– 4.25	1.25– 2.87½	.25 – 2.87½
September	16,210	4.00 – 4.87½	2.50– 3.75	....	2.37½
October	189,200	3.75 – 9.12½	2.00– 4.50	....	1.00 – 2.25
November	281,600	4.50 – 9.12½	2.75– 4.87½	....	1.50 – 3.00
December	19,390	4.25 – 6.12½	3.00– 5.00	....	1.12½– 3.75
1913.					
January	1,600	5.00 – 6.37½	3.00– 4.75	....	1.12½– 2.75
	508,000	3.75 – 9.12½	2.00– 5.00	....	1.00 – 3.75

[1] First sale, Sept. 22, 1911; last sale, Jan. 2 and 3, 1912.
[2] First sale, Sept. 17, 1912; last sale, Jan. 6, 1913.

The grape-storage investigations of the Bureau of Plant Industry included a study of the possibility of substituting the native-grown grapes for at least a portion of the imported fruit. It will not be possible to entirely replace the Spanish fruit save by the successful production in commercial quantities of varieties as long keeping as those shipped from Spain. Thus far it has been found impossible to hold any commercial California varieties throughout the entire winter season. The successful storage of California table grapes depends, therefore, upon their adaptability for keeping in sound and marketable condition through the holiday season at least.

EARLY GRAPE-STORAGE INVESTIGATIONS.

When the work of the Bureau of Plant Industry was begun in 1906 there were no established precedents to serve as guides, no systematic investigation of the behavior of California table grapes in storage having been made up to that time. It was necessary, therefore, to study the fundamental factors governing the behavior of the fruit, and the first efforts in the investigation were directed toward determining the nature of these factors.

Perhaps the most important of these influences is the type of package in which the fruit is shipped, and next in importance is the character of filler used. Practically all of the California grapes are

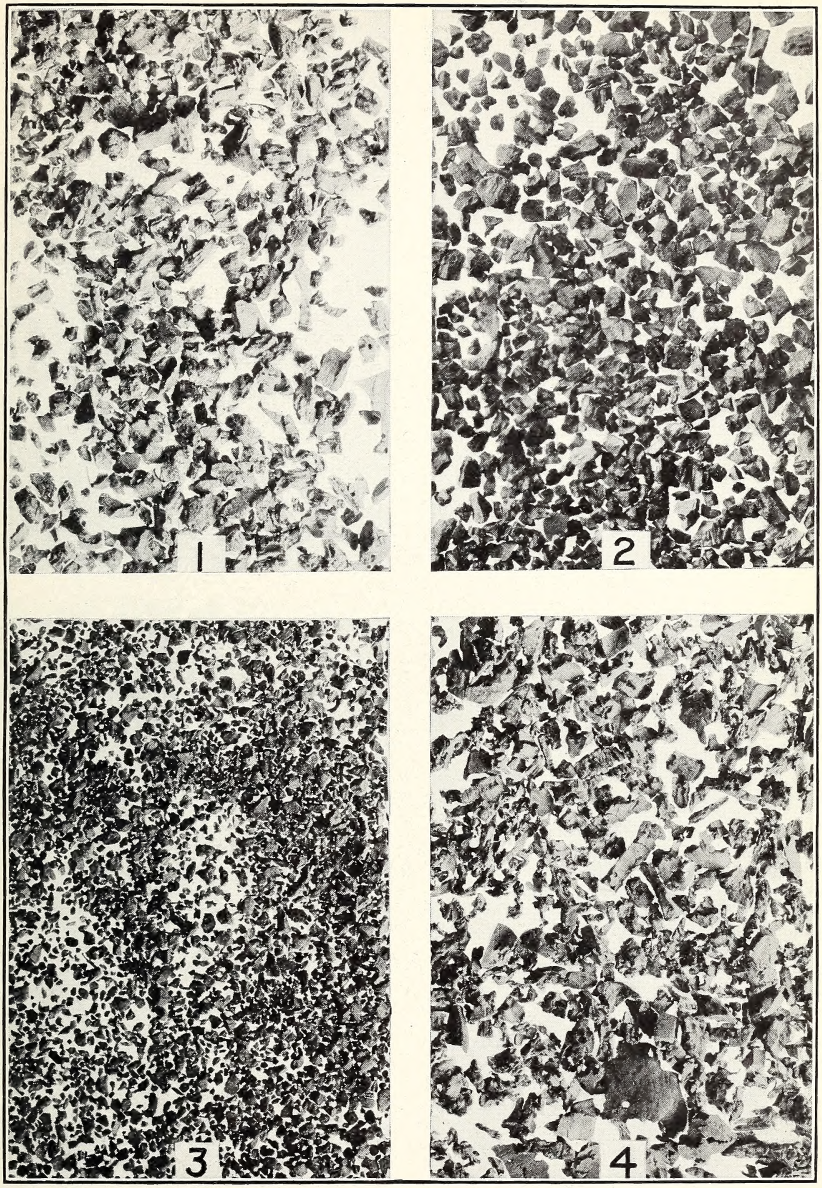


FIG. 1.—GROUND CORK, FROM A BARREL OF ALMERIA GRAPES, 1912. FIG. 2.—COARSE GRANULATED CORK, USED IN THE SEASON OF 1909. FIG. 3.—FINE GRANULATED CORK, USED IN THE SEASON OF 1909. FIG. 4.—CORK WASTE, 1912.

(All natural size.)

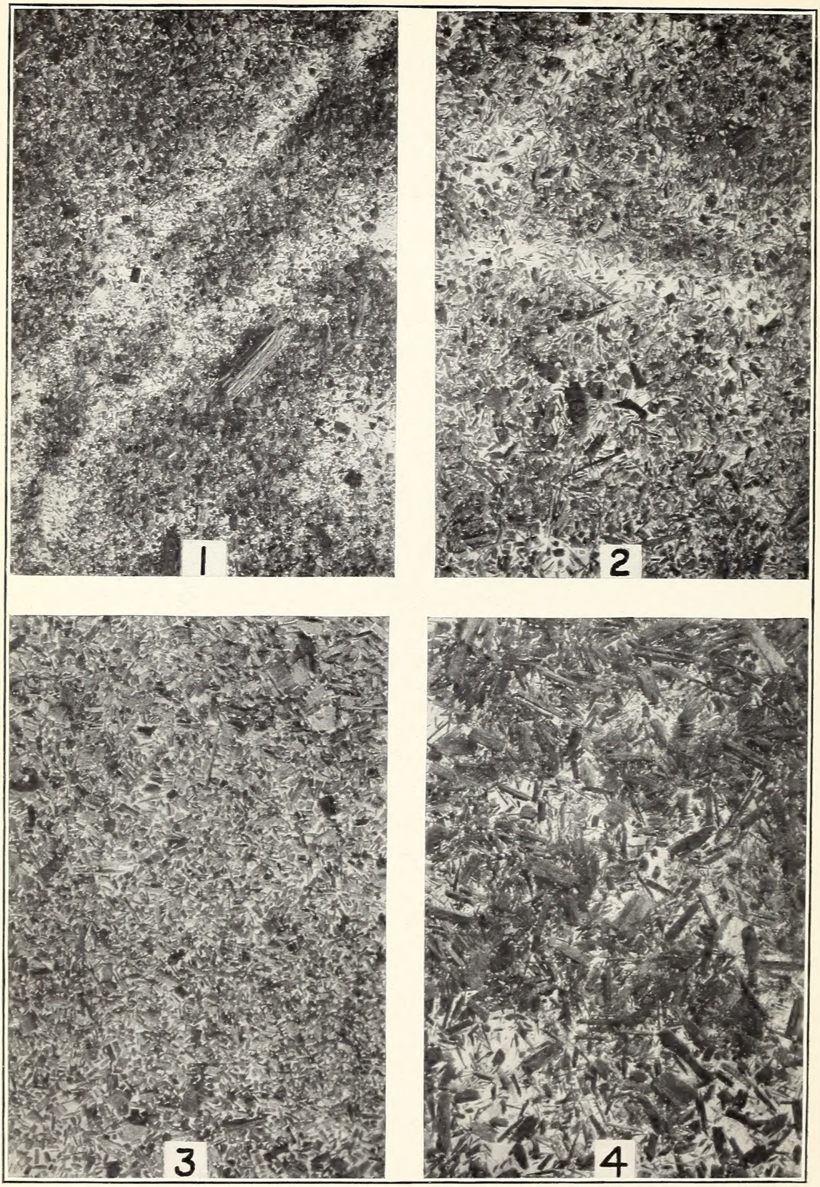


FIG. 1.—REDWOOD SAWDUST, FROM RESAWING, NOT FANNED, USED IN THE SEASON OF 1909. FIG. 2.—REDWOOD SAWDUST, FIRST SAWING, FINE, NOT FANNED, USED IN THE SEASON OF 1910. FIG. 3.—REDWOOD SAWDUST, MEDIUM FINE, NOT FANNED, USED IN THE SEASONS OF 1909 AND 1910. FIG. 4.—GROUND REDWOOD MILL SHAVINGS, NOT FANNED, USED IN THE SEASONS OF 1908 AND 1909.

(All natural size.)

marketed in splint baskets inclosed in slatted crates. The full or "double" crates formerly contained eight 5-pound baskets, but these are now used only to a slight extent. The smaller crates in common use, sometimes designated as half crates, contain four 5-pound baskets or two 10-pound baskets, packed high to make a full net weight of 24 to 26 pounds of fruit. Although no filler had been used in packing grapes for commercial shipments before the Bureau work was begun, systematic investigation soon showed the use of the ordinary commercial crate without a filler to be unsuitable for packing grapes intended for long-time storage. Tight boxes holding about 10 pounds of fruit were used in the first experiments, some of the grapes being packed with a filler and some without a filler. The tight packages without a filler proved to be as unsuitable for long storage as were the slatted crates. When a filler was employed, however, the period during which the grapes could be held in good condition was considerably lengthened, and for long storage a filler was found to be absolutely necessary.

When the search for a suitable material was begun by the Bureau workers the standard of comparison first used was cork dust, or ground cork, similar to that in which the Spanish grapes are packed. (Pl. I, fig. 2.) It was soon realized, however, that it would be practically impossible to obtain large quantities of cork on the Pacific coast at a price sufficiently low to make possible its commercial use, and the Department work therefore included the study of a number of possible substitutes. As there were no precedents to guide these early investigations, every possible filling material was thoroughly tested, including corn pith, shredded paper, wheat bran, corn meal, coconut pollen, ground and shredded tule, and redwood sawdust. It is unnecessary to describe in detail the results of these tests, since all except the redwood sawdust proved unsatisfactory for one reason or another. Fortunately for the California table-grape industry if this system of handling assumes large commercial importance, the redwood sawdust from the start proved even superior to the ground cork. The grapes were found to keep longer and in better condition under the same storage conditions when packed with a filler of redwood sawdust than with any other material. This surprising success was at first questioned, but repeated investigations during the past seven seasons have fully corroborated the results of the early work.

The reason for the better holding quality of redwood sawdust is not fully understood. In the first experiments the sawdust from planing mills was used (Pl. II, fig. 1), and as this was composed almost entirely of very minute particles its superior holding quality was thought to be due to the fineness of the material. A comparison of cork ground to the same degree of fineness showed, however, that something more than the mere size of the sawdust particles was responsible for the difference. It has not been possible as yet to ascertain the exact nature of this property.

VARIETIES TESTED.

The cold-storage experiments of the Bureau included tests of all the leading varieties of table grapes, some of which are grown commercially in California. These included Muscat, Malaga (Pl. IV), Flame Tokay, Thompson Seedless (Sultanina), Ferrara, Emperor (Pl. V), Verdal, Black Prince, Cornichon, Huasco, Bowood, Pizzutella, Perruno, Chasselas de Fontainebleau, Zabalkanski, Almeria (Ohanez, Pl. VI), and a number of other varieties not yet widely distributed.

Table IV shows the length of time during which the principal varieties were held in sound condition in cold storage. The figures show the number of days that elapsed from the time the fruit was placed in storage until deterioration of 5 per cent and 15 per cent occurred. These percentages were adopted after observations of the comparative marketability of fruit in different stages of deterioration. With less than 5 per cent of deterioration the grapes may be considered commercially sound. Between 5 and 10 per cent of deterioration is quite perceptible and affects the market value of the fruit. More than 10 per cent of deterioration is serious and subjects the fruit to a discount, while 15 per cent is about the commercial limit. Fruit showing more than this percentage of deterioration is practically worthless. In this table the figures for "deterioration" include both decay and berries shelled from the stems.

TABLE IV.—*Results of the California grape-storage experiments during the seasons of 1906 to 1911, inclusive, showing the minimum and maximum number of days the principal varieties were held at 32° F. before 5 per cent and 15 per cent of deterioration appeared.*

Varieties.	Method of packing and percentage of deterioration.					
	Redwood sawdust.		Granulated cork.[1]		Commercial crates without a filler.[1]	
	5 per cent.	15 per cent.	5 per cent.	15 per cent.	5 per cent.	15 per cent.
	Days.	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*
Almeria (Ohanez)	70 to 155	150 to 285	90 to 120	120 to 175	55 to 70	80 to 110
Cornichon	50 to 85	70 to 150	75 to 80	100 to 140	20	45 to 60
Emperor	80 to 120	95 to 180	65 to 80	90 to 105	35	60
Ferrara	[2] 140	160	80	90 to 95	35	45 to 60
Malaga	50 to 80	105 to 120	5 to 60	20 to 115	[2] 40	35 to 85
Muscat	[3] 8 to 75	24 to 110	5 to 60	15 to 110	5 to 30	20 to 65
Pizzutella	[4] 30 to 65	70 to 110	20 to 55	55 to 90	10 to 30	30 to 50
Flame Tokay	[5] 45 to 60	80 to 120	35 to 50	60 to 100	45	60
Verdal	[4] 55	95 to 130	60	90 to 110	5	15 to 25

[1] Seasons of 1906 to 1909. No cork filler or commercial crates were used after 1909.
[2] One season only, 1909. [3] Seasons of 1906 to 1910. [4] Seasons of 1906 to 1909. [5] Seasons of 1906 to 1911.

The minimum and maximum number of days before the development of 5 per cent and 15 per cent of decay, as given in this table, are the extremes found in the different years during which the work was in progress. The wide variations are due partly to seasonal conditions and partly to differences in the handling and shipping methods. In most cases the fruit was packed and sent to storage promptly, a delay of only one day intervening between packing and storing. During one or two seasons, however, there was an accidental delay ranging from three to five days in placing the packed fruit under refrigeration, and even this comparatively short interval had a material influence upon the length of time during which the grapes remained in sound condition. In interpreting the results it should be borne in mind that the figures shown are extremes. The minimum limit indicates the probability of success or failure in the storage work. The higher figures are likely to be misleading if one expects to accomplish the maximum every season or under all conditions of culture, handling, and age of vines. The fact that there are extreme ranges even under the best system of management and with the most careful methods of handling emphasizes the great importance of close attention to every detail.

Table V shows the approximate dates of packing and the subsequent storage seasons of the principal varieties tested when packed in redwood sawdust and stored at 32° F. These dates indicate the possible marketing periods of the different varieties as produced under present conditions in California. Later investigations may modify these seasons to some extent, but they are not likely to be shortened.

TABLE V.—*Packing and storage seasons of the principal varieties of California table grapes when packed in redwood sawdust and stored at 32° F., showing the approximate date when 5 per cent of deterioration developed and the approximate extreme limit of storage.*

Varieties.	Packing season.	Approximate date when 5 per cent of deterioration developed.	Approximate extreme commercial limit of storage.
Almeria (Ohanez)	Oct. 10 to 25	Jan. 1 to 15	Feb. 15 to Apr. 1.[1]
Cornichon	Oct. 2 to 15	Dec. 1 to 20	Jan. 1 to Feb. 1.
Emperor	Oct. 15 to 25	Dec. 15	Jan. 10 to 31.
Ferrara	Oct. 10 to 15	do	Jan. 15.[2]
Malaga	Aug. 25 to Sept. 20	Nov. 1 to 10	Dec. 1 to 15.[3]
Muscat	Sept. 1 to 15	Oct. 1 to 15	Nov. 15 to 25.
Pizzutella	Sept. 15 to Oct. 10	Oct. 15 to 31	Nov. 15 to 30.
Flame Tokay	Sept. 25 to Oct. 25	Nov. 20 to Dec. 10	Dec. 1 to Jan. 1.[4]
Verdal	Oct. 10 to 15	Dec. 1	Dec. 20 to Jan. 10.

[1] Under some exceptionally favorable conditions 15 per cent of deterioration did not develop in this variety before May 15; in some cases this percentage was shown by January 1. The grapes used in the tests were not of the best grade, the variety not being produced in commercial quantities in California. With a wider range of grapes from which to select lots for storage, a more uniform showing may be expected.

[2] Only one season's test in redwood sawdust.

[3] There seems to be considerable variation in this variety. In some cases the grapes held in first-class condition until January 15; in others the storage limit was reached before December 1. The bulk of the grapes shipped as this variety are of the latter class, and there seems to be sufficient ground to believe that the variety widely planted under this name in California is not the true Malaga.

[4] There is wide variation in the quality of Flame Tokay grapes, depending upon the age of the vines and the character of the soil upon which they are grown. Seasonal influences also play a very important part in the behavior of this variety.

The dates given in this table are not absolute; they are approximate averages made from many observations during three or four seasons and are meant to indicate the behavior of the different varieties in cold storage when handled with sufficient care to insure their being packed in sound condition. There is always wide variation between different seasons and frequently between different packages during the same season. This diversity is likely to be more pronounced when the fruit is packed under ordinary commercial conditions than is the case when the handling is done with extreme care under experimental conditions.

MOST FAVORABLE TEMPERATURE FOR GRAPE STORAGE.

Grapes used in the experimental storage tests were held in common storage at temperatures ranging from 55° to 60° F. and in cold storage at 38° and 32° F. Tables VI and VII give the results of the storage temperature tests, the data being presented in terms of the number of days elapsing before 5 per cent, 10 per cent, and 15 per cent of total deterioration developed. Comparable experimental series were used each season and the figures presented give a fair indication of the influence of the storage temperature upon the length of time that the grapes will remain in good condition. Table VI clearly shows the limitations of common storage as compared with cold storage at 32° F., for under the latter conditions nearly four times as many days elapsed before the development of 5 per cent of deterioration, while the 10 per cent period was not reached until three times as many days had passed, and the 15 per cent period almost three times as many.

TABLE VI.—*Comparison of storage temperatures for table grapes showing the number of days the grapes were held in common storage (from 55° to 60° F.) and cold storage (32° F.) before 5 per cent, 10 per cent, and 15 per cent of deterioration appeared during the season of 1908.*

Variety.	Packing.	Kind of storage and percentage of deterioration.					
		Common storage (55° to 60° F.).			Cold storage (32° F.).		
		5 per cent.	10 per cent.	15 per cent.	5 per cent.	10 per cent.	15 per cent.
		Days.	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*
Almeria	Cork, granulated	33	43	50	105	119	128
Do	Cork, shredded	40	55	64	118	135	146
Do	Redwood sawdust	46	62	72	157	190	212
Emperor	Cork, granulated	21	29	34	55	69	77
Muscat	do	10	18	25	65	75	82
Do	Cork, shredded	26	34	39	65	74	80
Do	Redwood sawdust	14	43	46	75	94	105
Pizzutella	Cork, granulated	23	30	35	63	69	75
Do	Redwood sawdust	12	19	24	72	84	91
Flame Tokay	Cork, granulated	12	19	24	57	64	70
Do	Cork, fine granulated	15	19	21	42	52	58
Do	do	17	21	25	77	87	96
Do	Cork, shredded	10	17	21	29	41	48
Verdal	Cork, granulated	15	21	25	68	84	93
Do	Cork, shredded	15	31	45	78	92	102
Do	Redwood sawdust	17	28	35	45	68	83

Table VII gives the results of storage tests made with Almeria and Emperor grapes at 32° and 38° F. during the season of 1909. The superiority of the lower storage temperature for longer holding periods is clearly demonstrated.

TABLE VII.—*Comparison of storage temperatures for table grapes, showing the number of days the grapes were held at 32° and at 38° F. before 5 per cent, 10 per cent, and 15 per cent of deterioration appeared during the season of 1909.*

Variety.	Packing.	Storage temperatures and percentage of deterioration.					
		32° F.			38° F.		
		5 per cent.	10 per cent.	15 per cent.	5 per cent.	10 per cent.	15 per cent.
		Days.	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*
Almeria	Crate (no filler)	63	75	82	29	40	46
Do	Cork, granulated	90	98	103	68	87	105
Do	Redwood sawdust	95	113	124	85	98	105
Emperor	do	100	114	122	62	90	103
Do	do	102	135	152	86	103	134

The differences shown in these tables do not tell the whole story. Grapes held at 32° F. were superior in general appearance and quality to those held either in common storage or in cold storage at 38°, and from this standpoint alone the lower temperature is desirable. In the later investigations of the Bureau of Plant Industry 32° F. was adopted as the standard and was used exclusively.

PREPARATION OF THE REDWOOD SAWDUST FILLER.

The redwood sawdust used in the first experiments was obtained from planing mills and consequently was made from dry lumber. The material was fine and contained a large proportion of dust and slivers. (Pl. II, fig. 1.) While the grapes held in excellent condition in this grade of sawdust, the fine particles and slivers clung tenaciously to the berries and the material packed so tightly in the interior of the bunches that it could only be dislodged with great difficulty. The fine particles became entangled with the dried persistent stamens around the pedicels of the berries and it was almost impossible to dislodge them completely even with a strong air blast. The market appearance of the fruit was greatly marred by the presence of these particles, and it became evident that they would have to be eliminated if the grapes were to be commercially acceptable. In the later experiments, therefore, the sawdust was sifted and only the larger particles were used. The appearance of the cleaned redwood sawdust resembles to some extent that of the cork used by the Spanish packers. (Pl. III, figs. 1 and 2.) It was found that the grapes held as well in this coarse sawdust as in the fine material and that the large particles separated readily from the grapes and could be easily shaken or blown out.

A most effective method of dislodging the sawdust is by means of an air blast, which frees the particles from the bunches without in any way injuring their appearance. When large quantities of the grapes are to be separated from the filler it is advisable to accomplish the work by means of such a device. In the investigations of the Bureau of Plant Industry a tray or frame covered with wire netting of one-fourth inch mesh has been used to good advantage. The packages of grapes are emptied into the trays or on the frames, and by means of an air blast the sawdust particles are blown through the wire netting, leaving the fruit free. For grapes with a tender skin this blast should not be too strong, 10 or 15 pounds pressure being ample to dislodge all the particles. The use of an air blast is not necessary to free the grapes from the coarser grade of sawdust, dislodgment being accomplished by merely shaking the bunches, as is done with the cork-packed grapes. The air blast greatly facilitates the work, however, and its use is suggested from that standpoint alone.

The quality of the sawdust and its method of preparation are of prime importance. It is necessary to have the redwood absolutely pure, as the slightest mixture of other woods, such as pine, cedar, or spruce has been found to taint the flavor of the grapes very quickly. Those who are interested in the packing of California grapes in this way should use every precaution to obtain redwood sawdust of the best quality. Some of the inquiries received by the Bureau of Plant Industry indicate that the importance of this point is not always sufficiently appreciated. Plates I, II, and III show natural-size photographs of the different grades of ground cork and redwood sawdust under observation during the course of the work. Plate 1, figure 1, shows the size and shape of ground-cork particles taken from a barrel of imported Almeria grapes. The suitability of this material is well known and no comment is necessary here. Plate I, figures 2 and 3, show the nature of the cork used in the Bureau experiments to show the relative adaptability of cork and redwood sawdust as grape-packing materials. It will be noticed that the coarser grade shown in Plate I, figure 2, is more uniform than is that used by the Spanish packers. Plate 1, figure 3, shows the fine cork used to determine whether or not the small size of the sawdust particles was responsible for the better holding quality of the grapes in that material. Plate I, figure 4, shows a sample of ground cork waste offered by one of the cork-manufacturing companies during 1912. The shreddy nature of this material makes it unsuitable for a

PLATE III.

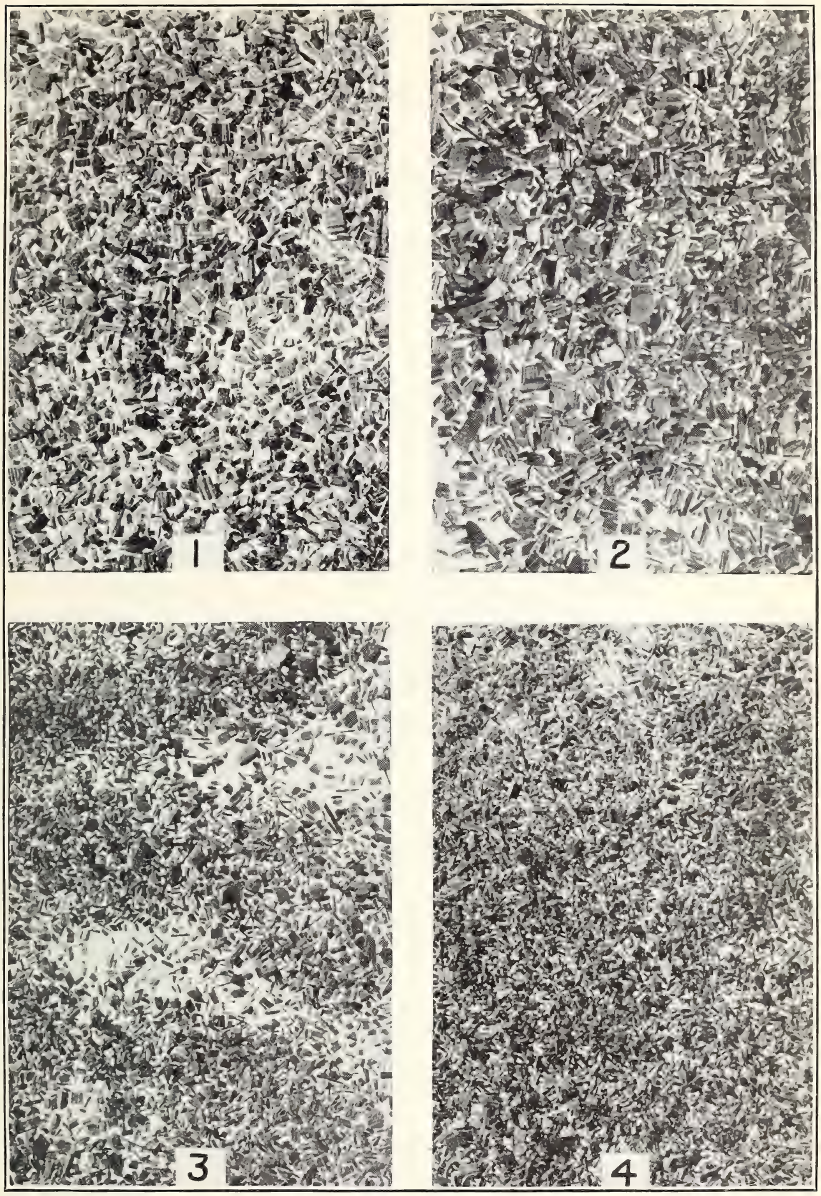
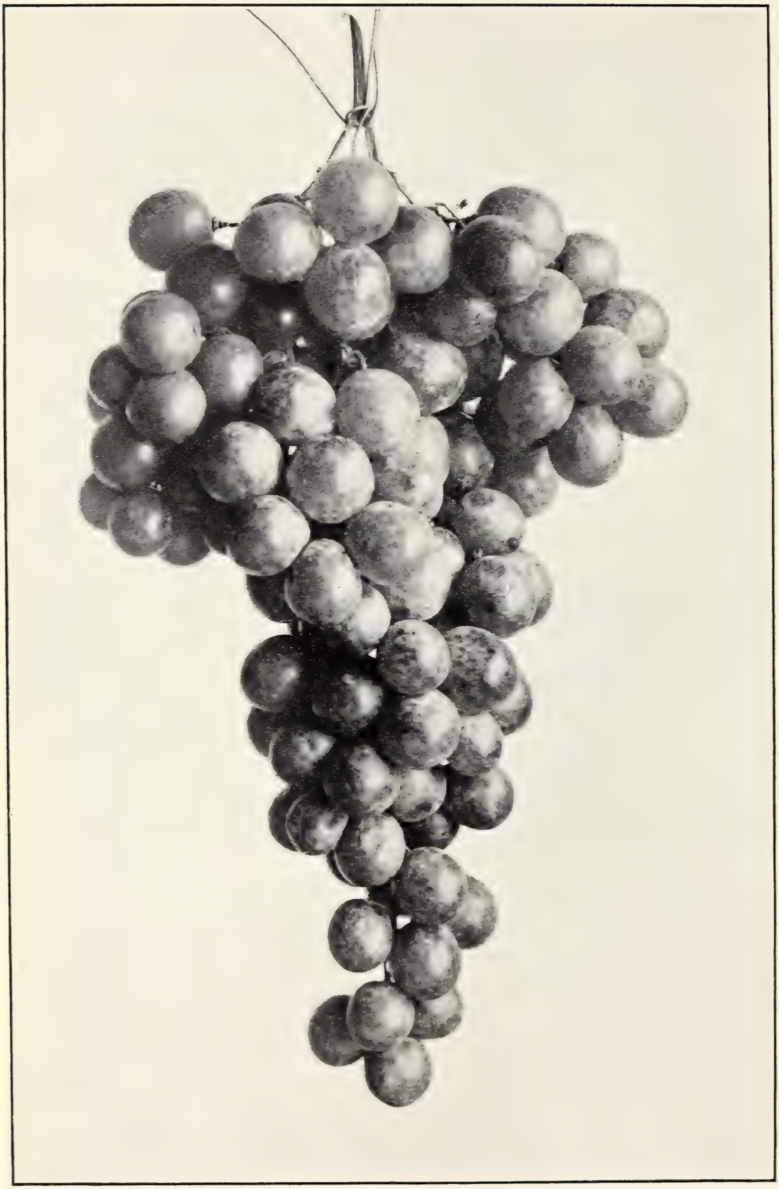


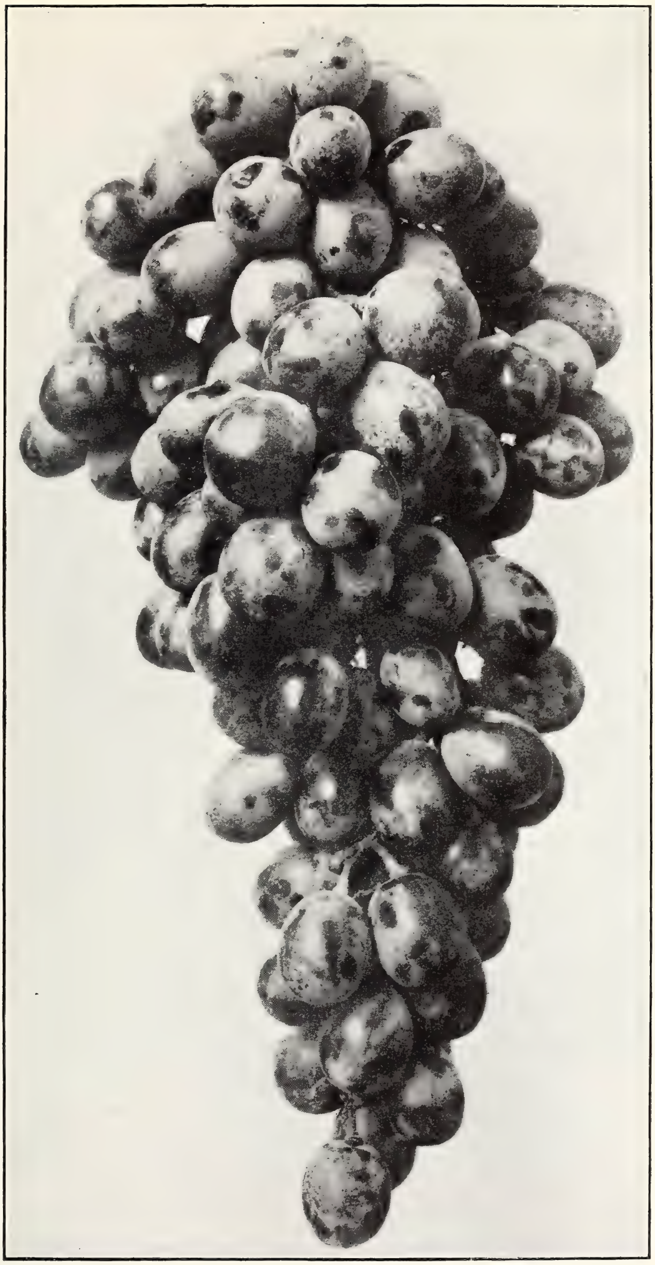
FIG. 1.—REDWOOD SAWDUST, COARSE, KILN DRIED, FANNED, USED IN THE SEASON OF 1911. FIG. 2.—REDWOOD SAWDUST, FIRST SAWING, COARSE, FANNED, MADE WITH EDGER SAW. FIG. 3.—REDWOOD SAWDUST, FINE, FANNED, FROM BAND SAW, USED IN THE SEASON OF 1910. FIG. 4.—REDWOOD SAWDUST, FINE, FANNED, USED IN THE SEASONS OF 1909 AND 1910.

(All natural size.)



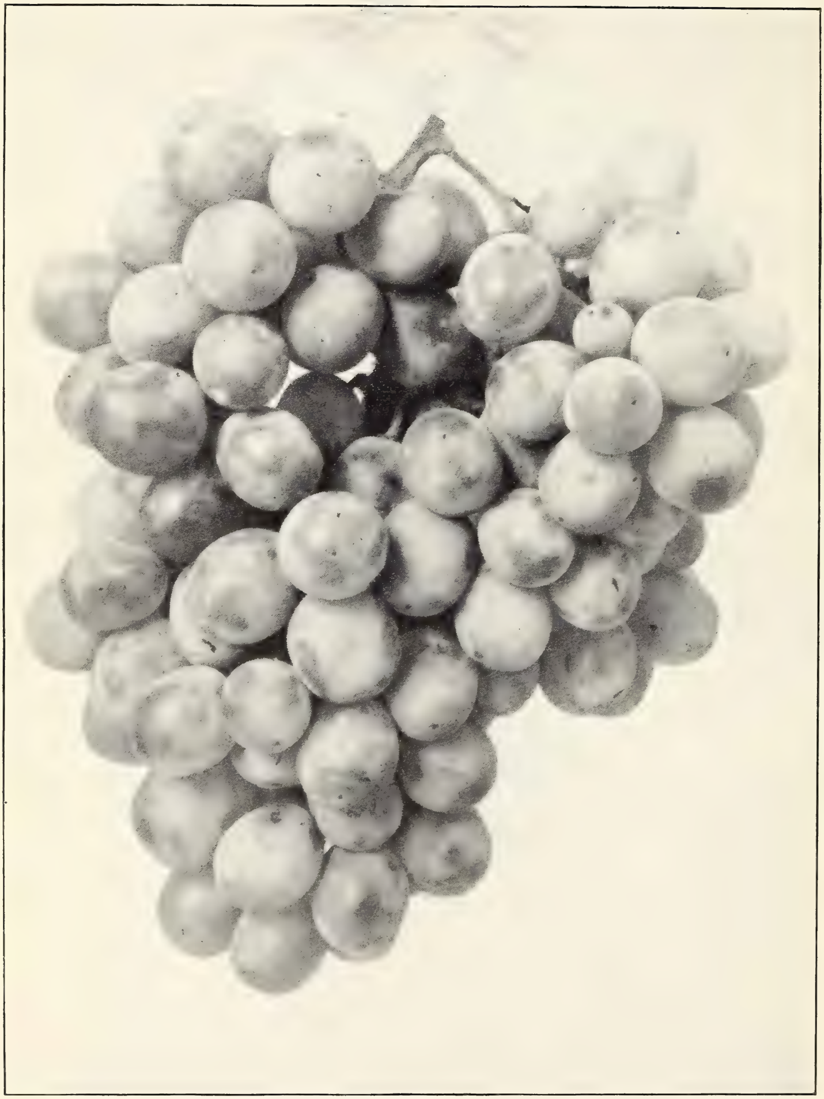
A BUNCH OF MALAGA GRAPES FROM A DRUM PACKED WITH REDWOOD SAWDUST, AFTER TWO MONTHS IN COLD STORAGE IN NEW YORK CITY.

(Greatly reduced in size.)



A BUNCH OF EMPEROR GRAPES AFTER 90 DAYS IN COLD STORAGE, PACKED IN REDWOOD SAWDUST. GROWN AT LODI, CAL. STORED AT PASADENA, CAL.

(Greatly reduced in size.)



A BUNCH OF CALIFORNIA-GROWN ALMERIA GRAPES AFTER 80 DAYS IN COLD STORAGE, PACKED IN REDWOOD SAWDUST. PASADENA, CAL.

(Greatly reduced in size.)

uniform pack, and its use can not be recommended until its efficiency has been more fully demonstrated.

Plates II and III represent the different grades of redwood sawdust used in the Bureau work. Plate II, figure 1, shows the fine material obtained from resawing operations in planing and finishing mills. This was the first material tested and gave the first favorable results from redwood sawdust. As has been mentioned before, the grapes will hold in first-class condition in this grade of sawdust, but the fine particles and slivers cling tenaciously to the berries and can not be dislodged from the interior of the bunches. Plate II, figure 2, illustrates a similar material obtained from the first sawing operations. This grade also contains too large a proportion of fine particles and slivers to make it an acceptable filler for grapes. Plate II, figure 3, is much better than either of the foregoing samples, but this also contains too large a proportion of fine splinters. Plate II, figure 4, shows the result of attempts to grind chips, waste blocks, and ends from planing mills. This material is wholly unsuited for grape packing. As yet no successful machine has been invented which will convert redwood waste into an acceptable packing material by means of special grinding. A number of devices have been tried, but always without success.

Plate III shows acceptable grades of redwood sawdust, the nearest approach to the ground cork used by the Spanish packers being those illustrated in figures 1 and 2 of this plate. Both of these grades were prepared by a sawmill company and were used in the commercial shipments of 1911. They illustrate the proper grade of sawdust for commercial shipments, and grape packers should make sure that their filler is of this character. Plate III, figures 3 and 4, show finer ground materials which are acceptable as fillers. There is, however, almost too large a proportion of small particles, which are liable to prove troublesome unless an air blast is used to dislodge them. It is hoped that these illustrations will serve as a guide to milling companies who prepare the material and to prospective packers.

The coarser redwood sawdust obtained from the first sawing of green logs contains a large proportion (about 50 per cent) of coarse particles and can be dried and cleaned with comparative ease. The importance of securing properly cleaned, dry sawdust can not be overemphasized. If it is obtained directly from the sawmill without special preparation it should either be kiln dried or thoroughly dried in the sun. Damp sawdust will not hold the grapes in good condition, and sawdust which has been allowed to ferment is likely to have a sour or pungent odor which will seriously taint the flavor of the grapes. The lumber companies on the Pacific coast are making arrangements to clean and dry the sawdust as it comes from the band saws, and as soon as there is sufficient demand these firms will be prepared to furnish large quantities of properly prepared material at prices which will render possible its use for commercial grape packing.

The fine particles can be easily separated from the coarse material by passing the dry sawdust through a revolving cylindrical sieve. A type of cleaning apparatus devised in the grape-storage investigations of the Bureau of Plant Industry consists of two cylindrical sieves from 6 to 10 feet long, mounted on a continuous shaft in an inclined position, the sieves being made of strong 6-mesh and 14-mesh wire screen. Sawdust of the proper grade is obtained by sifting the fine dust through the 14-mesh screen, while the coarse particles are carried over on the 6-mesh screen. Instead of using two separate cylindrical screens mounted on a continuous shaft, much space may be saved by having the wider mesh screen inclosed within a larger one of the 14-mesh size, the double cylinder revolving on an inclined shaft. The crude sawdust is emptied into the inner screen, which removes the coarse chips and splinters, allowing the residue to drop through into the outer, finer mesh cylinder. This screen in turn allows the objectionable small slivers and dust to sift through, while the desirable material is carried to the end of the cylinder and either emptied into a receiving bin or run directly into sacks. When packed in this material the grapes can be freed from the sawdust by slightly shaking the bunches on removal from the package.

During the season of 1911 one of the large redwood-lumber milling companies in California cooperated with the Bureau of Plant Industry in devising a practicable method of drying and cleaning the sawdust on a commercial scale. The successful outcome of this work enabled the company to furnish to some of the grape growers enough sawdust to pack several carloads of grapes, the cost of this material averaging about 14 cents per drum. It is believed, however, that with the construction of special machinery for drying and cleaning the sawdust, large quantities can be handled easily and quickly and the cost of preparation considerably reduced.

THE GRAPE DRUM OR BARREL.

A small barrel or drum has thus far been found to be the most acceptable container for grapes packed in sawdust. These drums are made of thin veneered cottonwood, lined with heavy strawboard. The drum used during the season of 1911 was about 12 inches in diameter, 17 inches in height, and had a net capacity of 27 pounds of grapes, the empty drum weighing about 5½ pounds and the filler about 9 pounds. A drum of larger size (Pls. VII and VIII) suitable for commercial shipments has now been adopted by some of the grape growers and shippers who wish to establish a package of standard size for the future. This drum holds from 33 to 36 pounds of grapes net. The drum used for the commercial shipments of 1912 will be discussed later.

The Almeria grapes imported from Spain are packed in barrels made of thin staves of oak, chestnut, or pine supported by wooden hoops. As was previously stated, the average net weight of fruit in these packages is about 47 pounds. These barrels are sometimes broken open in transit and the grapes greatly damaged by rough handling.

PACKING GRAPES IN REDWOOD SAWDUST.

The importance of packing quickly and of storing and cooling promptly can not be too strongly emphasized, especially when a filler of redwood sawdust is used. The temperature of the grapes at the time of packing is an important factor in preserving the fruit in good condition during a long holding period. Sawdust has a strong insulating effect, and even under the best conditions cooling within the package is comparatively slow. It is therefore imperative to have the grapes as cool as possible when packed. All fruit picked during the hot part of the day should be cooled overnight by stacking the field boxes in the vineyard, and the grapes should be packed the next morning before they have a chance to warm. In this way the

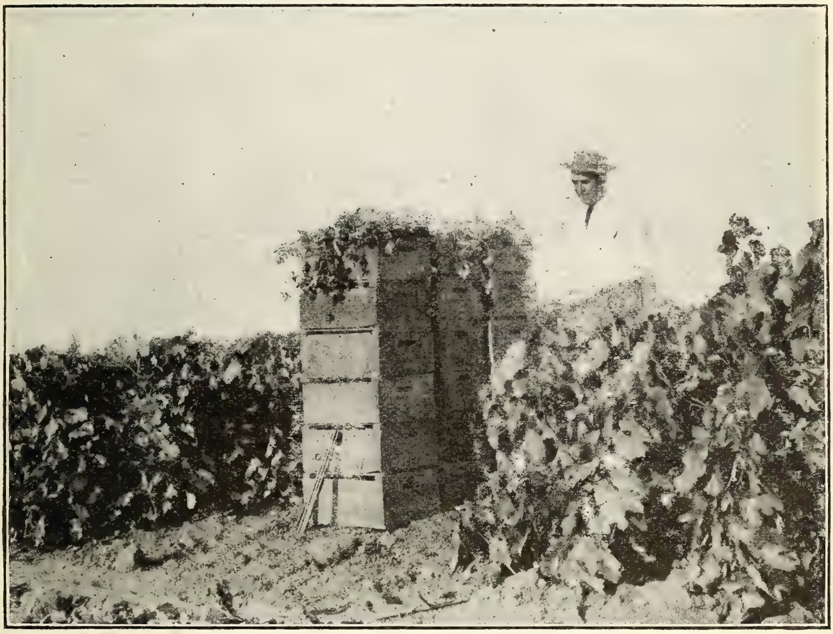


FIG. 2.—A stack of field boxes of grapes, showing the method used to cool the fruit during the night.

temperature of the fruit can be reduced 15 or 20 degrees, depending upon the natural night temperature. Figure 2 illustrates one method of stacking the field boxes in the vineyard for night cooling. If this method is impracticable, it is desirable to precool the packed fruit in well-refrigerated rooms as promptly as possible before loading on the cars. The ice of the refrigerator car can not safely be depended upon to lower the temperature of the grapes if they have been packed warm, for the tight package and the necessary close loading of the drums render cooling very slow. If the grapes are cooled before loading, however, the ice in the refrigerator car is only needed to offset heat leakage from outside, and the temperature can thus be held nearer the desired point. The ice is sufficient to accomplish this without difficulty, except in warm weather or in very inferior refrigerator cars. Even under exceptional weather conditions the rise of temperature is very slow within a cool grape package or a closely loaded car well equipped with refrigeration facilities.

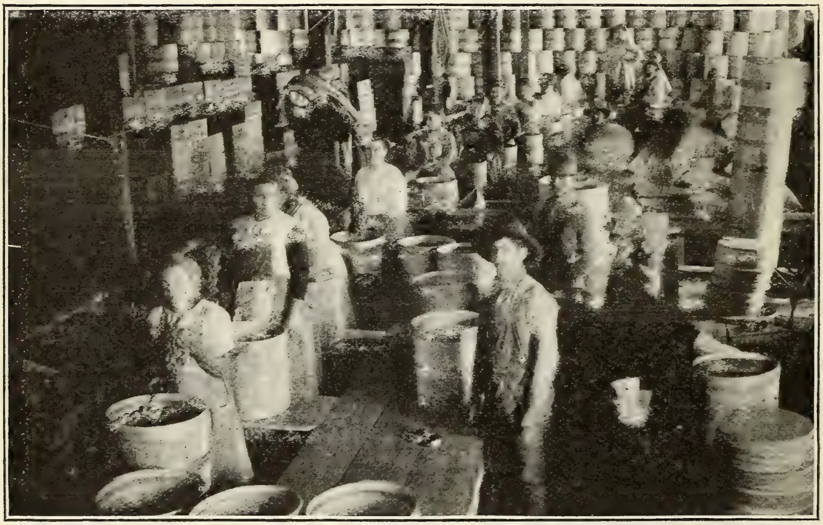


FIG. 3.—Packing Emperor grapes. The men shown in the foreground fill in the sawdust and shake it down between the grape berries by tapping the sides of the drum with rubber-covered handles, to be seen on the table in the middle of the picture. The sacks shown contain the dried and sifted sawdust.

The fruit must be carefully graded and all imperfect or injured berries removed. In order to obtain the best results a special crew of graders should be employed for this work. Inspection of the fruit in the packing house and in the market has shown that unless the closest supervision is maintained the quality of the pack is inferior when the culling and grading are done by the packers themselves. Moreover, proper inspection is possible only when the fruit is culled and graded before it is conveyed to the packers.

A convenient packing support for the drums and field boxes can be made of 2 by 4 inch scantling. Two strips of convenient length are fastened together 8 or 10 inches apart, with the proper framework to form a long packing table or bench, the top consisting of the parallel strips for holding the drums or boxes. The small barrels slip into this support and can be tilted against the side nearest the packer, being held firmly in place by their own weight. Figure 3 shows the interior of a packing house and illustrates an excellent arrangement of the field boxes, packing tables, and facilities for handling the sawdust.

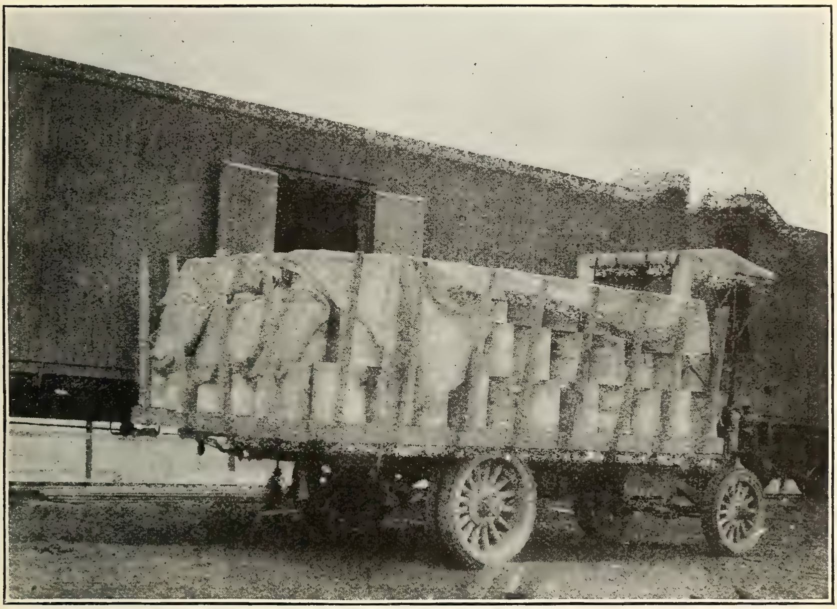


FIG. 4.—An automobile truckload of Emperor grapes packed in drums ready to load into a refrigerator car.

In packing the fruit the bottom of the drum should first be covered with about 2 inches of sawdust. The grapes should be packed in layers, usually one bunch deep, and as each layer is placed enough sawdust should be shaken over it to thoroughly sift through the bunches. Sharp jarring is required to fill all the interspaces between the berries, and this may be accomplished by shaking the drum slightly but rather abruptly back and forth, or, even better, by tapping the sides with the hands. Enough filling material must be used to prevent appreciable settling after the drum is filled, and this can be accomplished only by careful attention to the packing of each layer. The round form of the barrel permits a very close pack to be made, each drum generally containing three layers of grapes. The bunches may be laid either on the side or with the stem ends up, and the top layer may be "faced," if desired, in the same way in which an ordinary crate is packed. A cushion of sawdust about 2 inches and not less than 1½ inches thick should be placed over the top layer to prevent injury to the fruit from pressure of the cover. In handling grapes the greatest care should be exercised to prevent injury, for unless the berries are in sound condition when packed their holding quality is seriously impaired and considerable loss from decay is sure to follow.

The process of sifting the sawdust by hand into the layers of grape bunches is rather laborious and some form of mechanical device for accomplishing this work is very desirable, especially when a large quantity of fruit is to be packed. Much better results can also be secured if the regular packers are assisted by a number of helpers who handle the drums and the sawdust (fig. 3). When these operations are properly systematized, experienced workmen using equal care should be able to pack at a more rapid rate than is possible with the 4-basket crate.

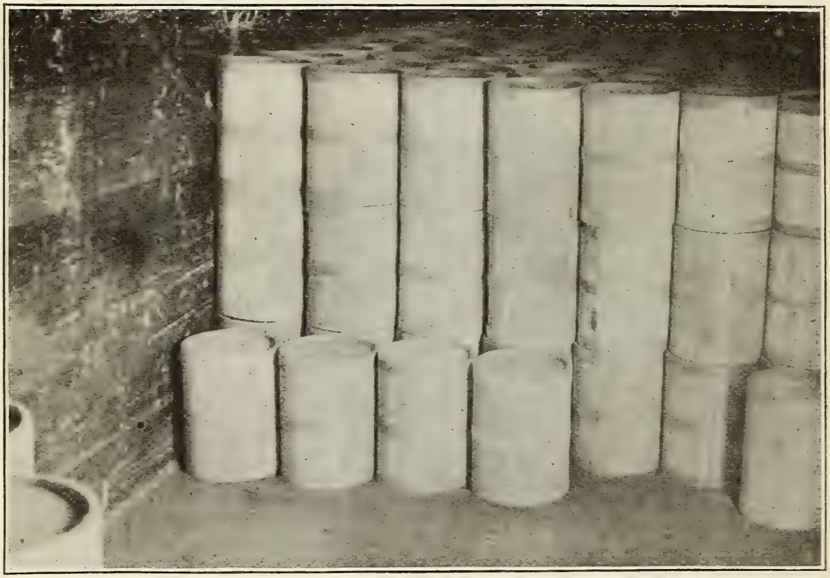


FIG. 5.—Small drums in a refrigerator car, showing the method of stacking employed.

LOADING THE DRUMS IN THE CAR.

Figure 4 shows an automobile truckload of Emperor grapes packed in drums and ready to stack in a refrigerator car. In loading the fruit for shipment the drums may be placed in straight rows lengthwise and across the car, three tiers high. By arranging the drums in straight rows the greatest amount of ventilation is secured for each package when the fruit is shipped under refrigeration. Only a narrow space in the center is needed for bracing. The ordinary car cleats used in bracing crates may be employed to separate the tiers, and these should also be placed on the floor, lengthwise of the car, to allow a circulation of air under the drums (figs. 5 and 6). The loading could be improved by placing strips $1\frac{1}{2}$ or 2 inches thick lengthwise on the floor of the car, allowing two strips for each row of drums and arranging them so that the vertical spaces between the drums are not closed. In some of the first shipments the drums were arranged in such a manner that the spaces between the rows were closed, thus preventing the circulation of air around the packages and largely nullifying the effects of refrigeration. If the grapes have been packed while cool or if the drums have been precooled to a temperature of about 40° F., open spacing between the packages is not so important. Cooled fruit may be stacked compactly if cleats are placed on the floor and against the sides of the car to allow a free circulation of air around the fruit mass. This serves to protect the drums against heat leakage through the car walls or floor.

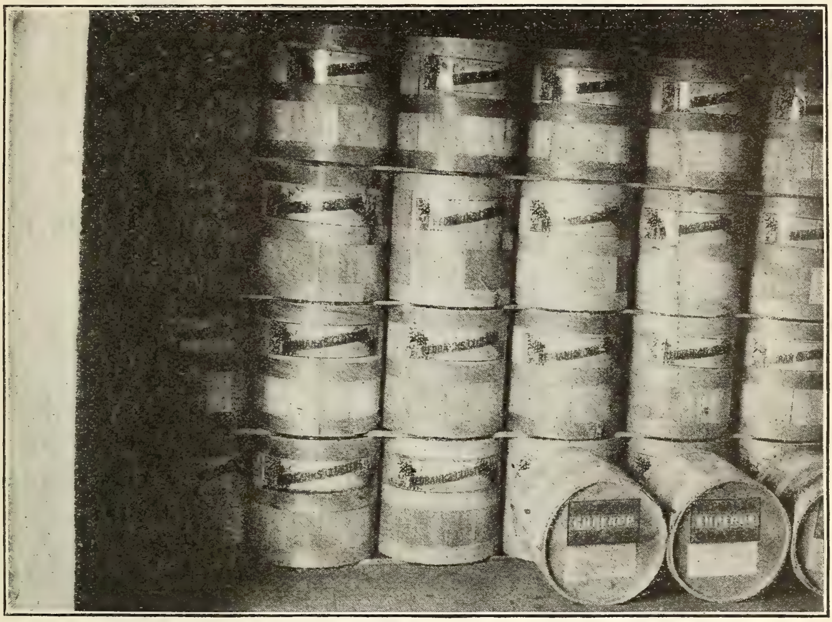


FIG. 6.—Large drums in a refrigerator car, showing the method of stacking employed. The three drums in front were temporarily laid down; they are not loaded in this position.

Figure 7 shows the drums braced in the middle of the car, the material used being 2 by 4 inch scantling. When this method is employed the crosspieces must be so placed that the pressure applied in tightening comes against the heads and bottoms of the drums; otherwise, the thin veneer sides of the packages will be crushed.

SELECTION OF GRAPES FOR STORAGE.

Those varieties of grapes which have open bunches are most suitable for storage purposes. Flame Tokay and similar compact varieties do not pack well for storage, because it is almost impossible to have the sawdust particles reach the interior of the bunches or to dislodge them afterwards. Further qualifications necessary for good storage grapes are adherence of the berries to the stems and the preservation of flavor and appearance during a considerable length of time.

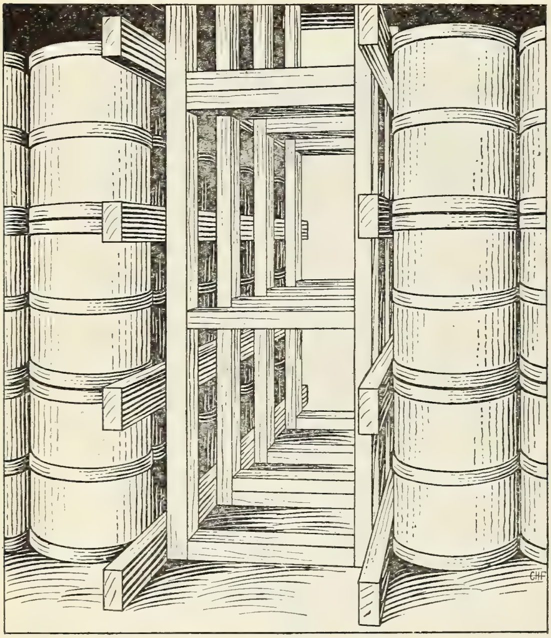


FIG. 7.—Drums of grapes in a refrigerator car, showing the method of bracing employed in the middle of the car. The crosspieces are so placed that the pressure applied in tightening comes against the heads and bottoms of the drums.

Only fruit of the best quality can be profitably held in storage. Inferior grades deteriorate rapidly and retain neither their fresh appearance nor their flavor long enough to pay for the extra cost of handling. The packing of grapes in this way is expensive, and it is therefore essential to devote the most painstaking attention to the proper preparation of the fruit. The grapes must be very carefully picked, handled, and packed in order to insure their being placed in the drums in sound condition. The berries should be free from blemishes, and the bunches should be most carefully culled in order to eliminate all imperfections. It must be remembered that redwood sawdust can not improve the grade of fruit packed in it, and that while this material will delay for a time the decay of unsound berries it can not prevent the development of mold on those which have been injured in any way.

COMMERCIAL TESTS OF 1911.

In the commercial tests made during the season of 1911, two separate shipments of Red Emperor grapes packed in drums with a filler of redwood sawdust were made from Fresno, Cal. The introduction into the fruit markets of the East of this method of handling California grapes was made possible by the cooperation with this Bureau of Mr. George C. Roeding, of Fresno, who was later joined by the Backer Bros., in packing the first commercial lot of Emperor grapes in drums. The first shipment consisted of one carload, which was held at Chicago and marketed throughout the season; the second shipment contained approximately one carload, which was held at New York, the bulk of the fruit being sold at auction in time for the Christmas trade. Very satisfactory prices were obtained for both lots and more fruit could have been sold to advantage had it been available. The returns from both the Chicago and New York lots were approximately the same, netting about $1.50 per drum f. o. b. California.[1] Notwithstanding the newness of the work, the inexperience of the packers, and the comparatively high cost of the drums and sawdust the shippers netted approximately $70 per ton for the grapes in the vineyard. It is safe to assume that under large-scale commercial conditions the cost of materials and the expense of handling can be greatly reduced. Whether as satisfactory results as those mentioned above can be obtained when a large number of cars are shipped remains to be demonstrated, however. The ultimate success of the enterprise will depend chiefly upon the elimination of all save the best fruit and upon the care used in the picking, handling, and packing operations.

An earlier consignment of Flame Tokay grapes shipped during the season of 1911 against the advice of the Bureau workers did not yield satisfactory results. The fruit was of an inferior grade and had been roughly handled and poorly packed. It held in good condition for only a short time and was sold at a considerable loss. While this shipment proved disastrous to the owners of the fruit, it serves as a deterrent object lesson and from that standpoint may be reckoned a useful and valuable experiment.

COMMERCIAL SHIPMENTS DURING THE SEASON OF 1912.

During the season of 1912, 19,834 drums of grapes packed in redwood sawdust were shipped from the San Joaquin Valley of California in accordance with the methods developed as the result of the Bureau work. The average carload lot was about 576 drums. One car of Emperors was sent to Seattle and one to Calgary, while less than carload lots went to various cities of the South and Middle West. The bulk of the shipments went to New York and Chicago,

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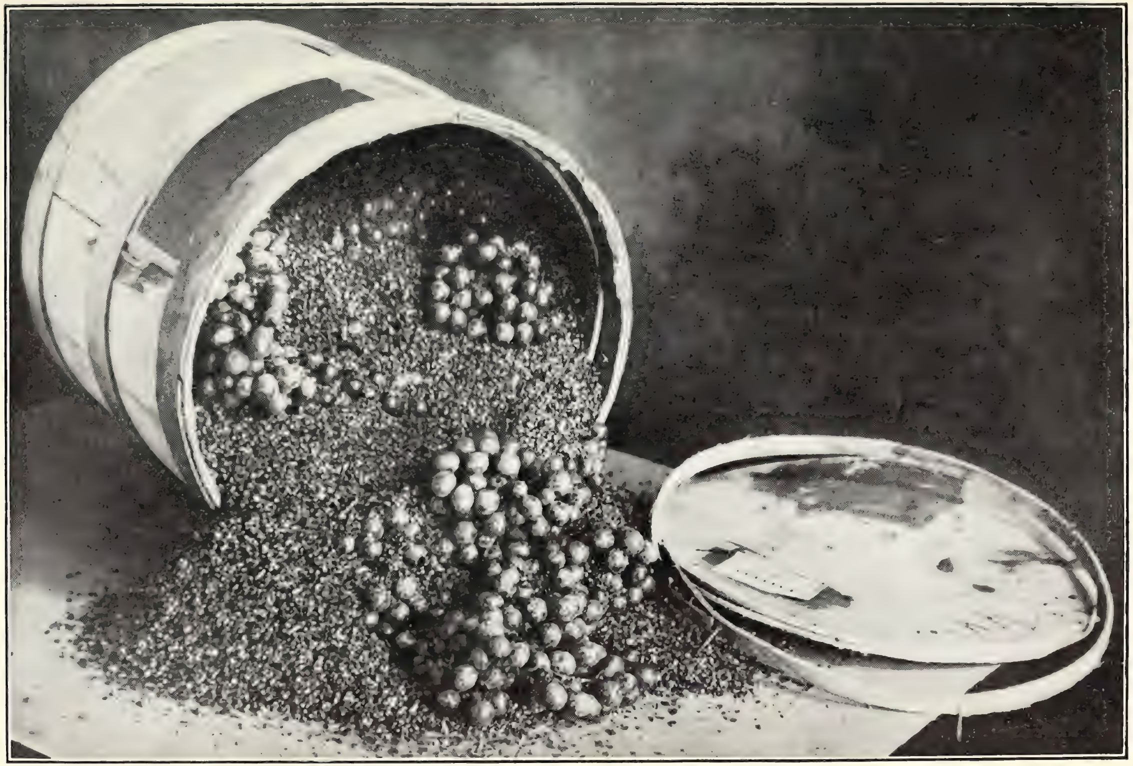
[1] The drums used in 1911 were smaller than those adopted by the shippers in 1912 and held approximately 27 pounds of grapes.

14½ carloads being sold at auction and private sale in New York alone. Most of the grapes were Emperors from the Fresno and Visalia districts, but a few carloads of Malagas were shipped from Sultana. They included 5,805 drums of the shipper-A brand from Visalia and the following lots shipped from Fresno: 3,310 drums of the shipper-B brand; 3,024 drums from shipper D; 1,491 drums from shipper E, and 1,123 and 300 drums from shippers G and F, respectively; 519 drums were sent by shipper C; 86 by shipper H; and 14 by shipper J. From the Lindsay district 2,045 drums were sent by shipper K, and from Sultana 1,833 drums were sent by shipper L and 284 by shipper M. These last two consignments were of Malaga and Cornichon. The shipment of Emperors began on October 16 from Las Palmas and continued until November 29.

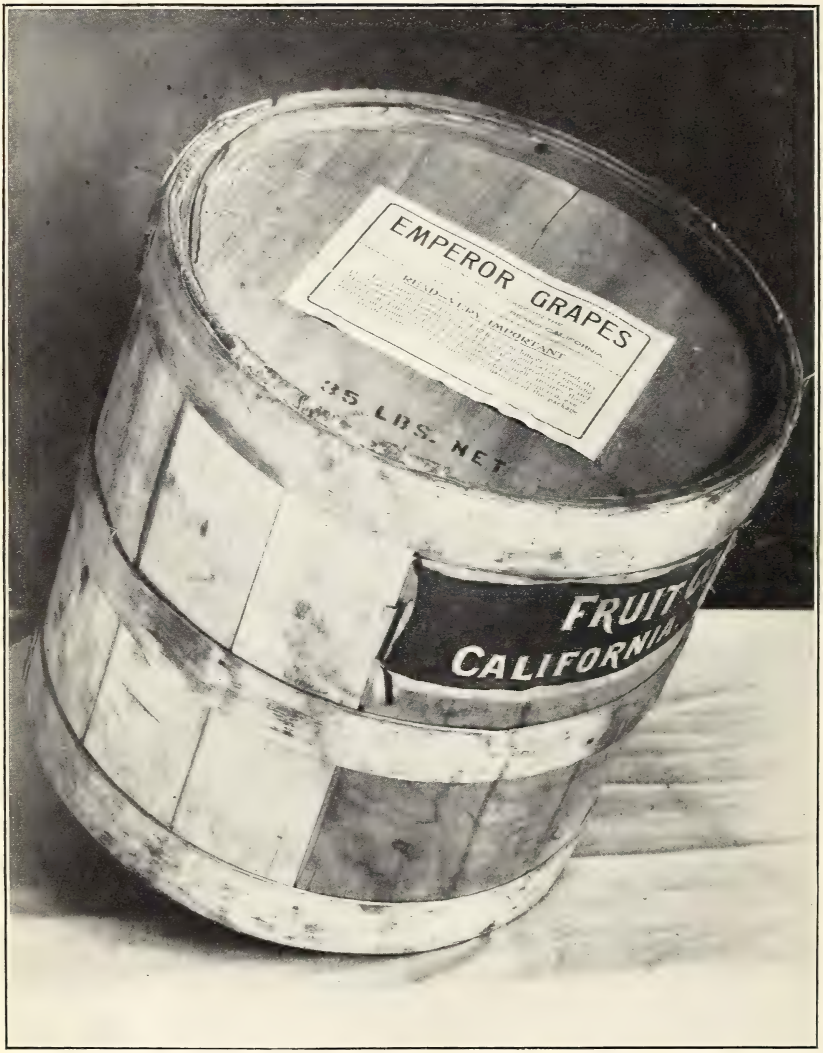
In addition to the sawdust-packed shipments, which were handled largely under the supervision of the Bureau workers, about 30 cars of Emperor grapes, packed in ground cork, were also shipped from the Fresno district. A number of these cars were shipped to Buffalo, Pittsburgh, New York, Boston, and one or two southern cities, but most of them were consigned to various points in the Middle West, between Chicago and New Orleans. These grapes were disposed of partly at private sale and partly at auction, and in several cities were sold at the same time as those packed in sawdust. The poor condition of the fruit when offered for sale and the low prices received for many lots bear out the results of the Bureau experimental investigations on packing materials. Most of these grapes were shipped under ventilation without refrigeration, and were held in common storage after arrival in the East; in some cases the cars were sidetracked and held without unloading for two or three weeks after arrival. The early deterioration of the fruit did not permit keeping it in sound condition for the holiday market.

At the time when the grapes which were packed in sawdust were offered for sale and were in prime condition, the offerings of the cork-packed Emperors showed in some cases more than 50 per cent of decay and sold at a price which did not cover freight charges. It should be borne in mind that the poor showing made by these shipments was not due solely to the use of cork instead of sawdust. While the Bureau work has proved conclusively that grapes packed in redwood sawdust hold longer and better than those packed in cork, the difference in their favor is not as great as that shown in the shipments noted above, other things being equal. The variable quality of the grapes, improper or rough handling, delay in packing the fruit after it had been picked, shipment without refrigeration, and holding in common instead of cold storage, as well as the use of cork, were the



A DRUM OF MALAGA GRAPES PACKED IN REDWOOD SAWDUST, AFTER TWO MONTHS IN COLD STORAGE IN NEW YORK FROM THE COMMERCIAL SHIPMENTS OF 1912.

(The sawdust particles may be easily dislodged from the grape bunches.)



Drum Used in the Commercial Shipments of Grapes in 1912. This Drum is 16¼ Inches in Diameter Outside and 15⅝ Inches in Diameter Inside, 16¼ Inches High Outside and 15⅞ Inches Between the Heads Inside. Capacity, 30 to 35 Pounds of Grapes Net.

chief factors responsible for the poor condition of the fruit on the market.

Some poor lots of Emperor grapes which were packed in redwood sawdust also failed to hold in sound condition during the storage season. This is shown by the low prices received for certain brands at the auction sales. Shipment under refrigeration and cold storage after arrival did not prevent deterioration due to weakness in the fruit itself or to lack of care in packing. The excellent initial condition of the more carefully selected Emperors not only insured the holding of these grapes in first-class condition for the holiday market, but it also permitted the reshipment by express of a large number of drums to distant markets.

WEIGHT OF GRAPES AND PACKING MATERIAL IN THE DRUM.

No figures are available for the cost of packing grapes in cork. A drum 12½ inches in diameter by 15 inches between covers, inside measurement, and smaller in size than that used for the sawdust-packed fruit, was used in 1912 for the grapes shipped in cork. The gross weight of these packages averaged 32 pounds, the net weight of the grapes being 25¾ pounds, of the cork 2 pounds, and of the drum 4¼ pounds. In packing some of these drums for experimental purposes, however, the Bureau workers found it necessary to use nearly double this quantity of cork, or about 4 pounds. When only 2 pounds of the filler were used, the material was not shaken down well enough in the course of packing. When the drums were opened on the market, the cork had usually settled 2 or 3 inches from the lid, the top layer of grapes being exposed and generally showing more or less bruising and some decay.

The drum for the sawdust pack measured 15⅝ inches in diameter and 15⅝ inches between covers, inside measurement, and 16¼ inches outside, for both diameter and height. (See Pls. VII and VIII.) The maximum weight of grapes which could be packed in this drum, allowing sufficient space for sawdust at top and bottom, was 35 pounds. Many of the packers did not attempt to hold the net weight of grapes above 30 pounds, while the quantity of fruit in some of the drums was considerably less than 26 pounds, the different packages thus showing great variation. Three typical drums showed the following weights of packing materials and grapes:

With a gross weight of 50½ pounds there were 33¼ pounds of grapes and 11½ pounds of sawdust, the empty drum weighing 6 pounds.

With a gross weight of 51½ pounds, the grapes weighed 34¼ pounds, the sawdust 11¼ pounds, and the drum 6 pounds.

With a gross weight of 55½ pounds, the grapes weighed 38 pounds, the sawdust 11½ pounds, and the drum 6 pounds.

The gross weights of 50 drums packed by shipper A varied from 48 to 54 pounds, this variation being almost entirely due to differences in the net weights of the grapes contained in the packages. The drums packed by shipper D also varied widely in the net weight of the fruit. There was a variation ranging from 19 to 28 pounds of grapes, and the uncertainty regarding the actual quantity of fruit contained in each package rendered fair bidding on the part of buyers at the auction sales very difficult. The contents of drums of several of the other brands also varied considerably, as no real effort was made to pack a uniform quantity of grapes, the net weights ranging from 22 to 30 pounds. Each drum packed by shipper B contained 35 pounds net, the proper quantity of grapes being weighed out for each packer. The importance of having each drum contain a definite quantity of grapes (which can be indicated by a proper mark) should be clearly understood. Buyers after purchasing the drums were severe in their criticism of those brands which showed a varying weight of fruit.

IMPORTANCE OF CAREFUL GRADING.

In addition to the inequality in the contents of the drums, the lack of proper grading before packing was a source of criticism by buyers. The fruit was frequently not uniform in color and most of the drums contained bunches of all sizes, small straggling ones being placed side by side with large clusters. If the best results and highest prices are to be realized packers must give special attention to careful grading, and it is strongly recommended that the grapes be graded for uniformity of color as well as for the size of the bunches. It is a great mistake to pack loose, straggling bunches with the finer fruit. The value of careful attention to this part of the work is shown in the pack of shipper B, who kept the large bunches separate and marked them "Fancy clusters." The auction price for this grade ranged from $4.20 to $5 per drum, a difference of $1 to $1.50 per drum above the regular price. The common method of selling these grapes in all of the large markets will probably be by auction, the quality of the fruit being determined by the inspection of sample drums. It should be remembered, therefore, that one or two small, poor bunches among the grapes shown as samples will have a considerable effect upon the price offered for the whole lot, for unless the fruit is of uniform quality the price will be discounted.

AUCTION SALES OF CALIFORNIA STORAGE GRAPES.

At the auction sales of the California fruit the grapes are emptied out on small tables for inspection, usually two drums being opened from every lot of 50 or 100 listed for sale. The fruit buyers make notes on the different brands offered, and at the sales, which are held later, bids are made from these notes. The different lots are kept separate at the auction, so that each brand establishes a reputation of its own, and in time the reputation of a brand, based on the holding quality of the fruit and its behavior on the market, will largely influence the price which buyers are willing to pay.

The handling of grapes packed in drums will necessitate some changes in the manner of selling the California product in eastern markets. In general, the methods which have been adopted at the auction sales are the same as those used in selling the imported Almeria grapes. In the case of the latter, however, the different lots are emptied on an elevator platform, which is run up to the center of the auction room where the grapes are inspected and sold. The bidding on the different lots is generally very rapid, and the business consumes only a minute or two. In this way large numbers of barrels are quickly sold, frequently 10,000 to 20,000 being disposed of at a single sale.

REFRIGERATION OR VENTILATION IN TRANSIT.

A test of the possibility of shipping sawdust-packed grapes without refrigeration was made during the past season. One carload of grapes in drums, composed of shipments from the F, G, D, and B vineyards, was forwarded from Las Palmas on November 5, the car being handled under ventilation while en route. The fruit arrived in Jersey City on November 17 and went into cold storage on November 21, the condition on arrival being generally good. The drums were placed on end in the storehouse and an average temperature of 32° F. maintained. An examination made of the stock showed the fruit from shipper B to be of good quality, well bunched, and in good condition. The D-vineyard fruit had fair-sized bunches, with medium-sized berries, but the barrels were rather light as to weight of fruit. The Emperors from shipper G showed irregular quality, some berries being small and others large; and the F-vineyard fruit was of irregular size, some of it being very small and straggling. Examination of the fruit after it had been held in cold storage for 10 days showed that it was deteriorating very rapidly, and for this reason it was disposed of as quickly as possible. Most of the shipper-B fruit was sold at private sale, but the bulk of the carload was sold at auction in small lots on December 10, 12, 17, and 19. The average prices realized on this fruit ranged from $1.17 per drum for the G-vineyard fruit, one lot of 70 drums of this brand selling for 95 cents a drum, to $2.81 per drum for the shipper-B fruit, the average carload price being $2.13 per drum. These returns were considerably below those received for the grapes shipped under refrigeration, owing to the larger percentage of decay in the fruit forwarded in the ventilated car.

While some of the lots were placed in storage 12 days after leaving Fresno, in other cases 16 or 17 days elapsed between the dates of shipment and storage in New York. There was a variation of 7 days in the length of time which elapsed between the shipment and storage of the different cars from shipper A, the time in transit ranging from 15 to 22 days. It is important to know the conditions under which the grapes are held in transit, especially when there is a delay en route or in transferring the fruit to the warehouse. If the cars are kept fully iced during the whole period (including the time while awaiting transfer) there will probably be no injurious results from the length of time during which the fruit is in transit. But if during warm weather the cars are held for 4 or 5 days without reicing, the effect may be serious, as the fruit will warm sufficiently to impair its keeping quality.

RECORD OF SALES OF GRAPES IN DRUMS.

The Emperor grapes sent to New York by shipper A were sold principally at private sales, but all other lots were disposed of at the regular fruit auctions held on Erie Pier No. 20. Table VIII gives a record of the number of drums of Emperor grapes consigned to New York by each of the California shippers and the average prices received for the different brands. The general average for the 8,596 drums was $2.90.

TABLE VIII.—*Summary of the sales of different brands of California Emperor grapes in drums, packed in redwood sawdust and held in cold storage in New York, season of 1912–13.*

Designation of shipper.	Number of drums.	Average price.	Designation of shipper.	Number of drums.	Average price.
A	4,059	$3.13	F	132	$1.69
B	1,780	3.00	G	268	1.59
C	514	2.75			
D	1,195	2.75	Total and average	8,596	2.90
E	648	2.36			

Tables IX and X give the records of the sale of Emperor grapes in drums at New York and Chicago during the season of 1912–13. Most of the different shipments were broken up and sold in small lots on different days, the entire carload being disposed of within a week or 10 days after the first withdrawals were made. The dates of sale given in Tables IX and X, therefore, are the days on which the last of each cargo was sold.

TABLE IX.—*Record of shipments of Emperor grapes in drums, packed in redwood sawdust and held in cold storage and sold in New York, season of 1912–13, showing the gross receipts and average prices.*

Date of shipment.	Shipped from—	Designation of shipper.	Date of sale.	Number of drums.	Gross receipts.	Average price.
1912.						
Oct. 17	Las Palmas	D	Jan. 7, 1913	650	$1,804.45	$3.01
19	do	C	Dec. 13, 1912	430	1,136.02	2.64
19	do	D	Dec. 12, 1912	203	532.96	2.56
21	do	B	Jan. 5, 1913	552	1,815.59	3.29
21	do	C	Dec. 30, 1912	84	278.30	3.31
21	Sanger	E	Dec. 5, 1912	648	1,518.60	2.34
23	Las Palmas	B	Dec 19, 1912	358	961.50	2.68
23	do	D	do	190	466.80	2.46
23	do	G	do	40	59.60	1.49
27	do	B	Dec. 28, 1912	566	1,669.13	2.95
27	do	G	Dec. 27, 1912	70	118.55	1.69
28	Redbanks	A	Dec. 20, 1912	581	1,730.20	2.98
28	do	A	Dec. 10, 1912	582	1,705.50	2.93
28	do	A	Dec. 20, 1912	581	1,725.32	2.97
29	do	A	Dec. 27, 1912	581	1,746.84	3.01
29	do	A	Jan. 3, 1913	581	1,795.80	3.09
29	do	A	do	581	1,985.39	3.42
Nov. 5	do	A	Nov. 21, 1912	5	16.80	3.36
5	Las Palmas	D	Dec. 1–19, 1912	147	341.55	2.32
5	do	F		132	223.90	1.69
5	do	B		200	561.25	2.81
5	do	G		113	131.70	1.17
11	Redbanks	A	Jan. 7, 1913	572	2,022.40	3.54

TABLE X.—*Record of shipments of Emperor grapes in drums, packed in redwood sawdust and held in cold storage in Chicago, season of 1912–13, showing gross receipts and average prices.*

Date of shipment.	Shipped from—	Designation of shipper.	Date of sale.	Number of drums.	Gross receipts.	Average price.
1912.						
Oct. 16	Las Palmas	D	Dec. 16, 1912	600	$1,804.45	$3.01
18	do	D	Dec. 11, 1912	346	949.10	2.74
18	do	B	do	292	656.10	2.25
20	do	D	Dec. 18, 1912	145	455.00	3.14
20	do	C	do	5	15.75	3.15
20	do	G	do	323	919.40	2.85
20	do	B	do	166	518.10	3.12
22	do	B	Dec. 20, 1912	216	632.80	2.93
22	do	D	do	262	833.95	3.18
22	do	G	do	160	226.75	1.42
23	Sanger	E	Dec. 18, 1912	648	849.10	1.31
Nov. 2	Las Palmas	B	Dec. 27, 1912	166	602.10	3.63
2	do	D	do	422	1,519.40	3.60
2	do	G	do	4	10.80	2.70
2	Redbanks	A	Jan. 7, 1913	571	1,979.20	3.47
8	Las Palmas	G	Dec. 23, 1912	199	276.65	1.39
8	do	F	do	168	226.70	1.35
8	do	B	do	221	689.60	3.12

Six carloads of the shipper-A brand were sold at private sale during December and January at an average price of $3.06 per drum. A large portion of this fruit was reshipped to Atlantic coast cities, including Boston, Philadelphia, Baltimore, Richmond, and Jacksonville. Several shipments of from 100 to 200 drums each were made to Cuba and other points in the West Indies. Sample drums of the shipper-B brand were sent to some of the leading fruit handlers in

Buffalo, Pittsburgh, and Philadelphia, and resulted in a number of requests for small shipments to these cities. In Buffalo 160 drums were sold on December 23 and 30 for an average price of $3.80 per drum. About the same price was realized in Pittsburgh for a lot of 100 drums, and satisfactory sales were also made in Philadelphia. Table XI gives a record of the auction sales in Buffalo, Philadelphia, and Pittsburgh.

TABLE XI.—*Record of auction sales of California Emperor grapes in drums, packed in redwood sawdust and held in cold storage in New York and sold at Philadelphia, Pittsburgh, and Buffalo, season of 1912–13.*

Place of sale.	Date of sale.	Number of drums.	Designation of shipper.	Auction price per drum.
	1912.			
Philadelphia, Pa	Dec. 16	40	D	$3.00
	16	40	A	3.25
	19	40	B	3.25
	19	60	D	2.75
	24	40	A	3.50
	24	60	B	3.25
Pittsburgh, Pa	Dec. 19	10	B	3.60
	19	10	D	3.60
	19	10	A	4.35
	21	20	B	3.60
	21	20	D	3.60
	21	20	A	4.35
Buffalo, N. Y	Dec. 23	10	B	3.65
	23	10	B	3.65
	23	10	B	3.75
	23	10	B	3.85
	23	10	D	3.75
	23	10	D	3.80
	23	10	D	3.80
	23	10	D	3.80
	23	10	A	3.85
	23	10	A	3.85

A carload of grapes from shippers D, B, and G sold at an average price of $2.46 per drum at Duluth, Minn. A carload made up of drums from shippers E, B, H, and J sold at Seattle, Wash., brought the following average prices for the respective brands: $2.45, $2.50, $1.81, and $1.90. At Calgary, Canada, a carload of Emperor grapes from shipper A sold at an average of $2.48 per drum, and at Lincoln, Nebr., an average price of $2.47 was received for the same brand of fruit. Drums of Emperor grapes from shipper A in less than carload lots sold at Omaha, New Orleans, Waco, El Paso, Austin, San Antonio, and Lincoln realized average prices ranging from $2.45 to $2.72. Table XII gives the details for these shipments. These lots, with the exception of those sent to Seattle, were sold f. o. b. shipping point. Therefore, the dates of shipment and sale are the same. The freight and refrigeration charges have been added to the selling prices, however, and the gross receipts and average prices given in this table are comparable with the prices received in New York, Chicago, or any other auction market.

TABLE XII.—*Record of shipments of Emperor grapes in drums, packed in redwood sawdust and held in cold storage, season of 1912–13, showing the place where sold, gross receipts, and average prices.*

Date of shipment.	Shipped from—	Designation of shipper.	Sold at—	Date of sale.	Number of drums.	Gross receipts.	Average price.
1912.							
Oct. 26	Las Palmas	D	Duluth	Oct., 26	54	$132.84	$2.46
26	do	B	do	do	368	905.28	2.46
26	do	G	do	do	214	526.44	2.46
27	do	E	Seattle	Nov. 15	195	487.00	2.45
27	do	B	do	do	205	512.50	2.50
27	do	H	do	do	86	163.40	1.81
27	do	J	do	do	14	26.60	1.91
30	Redbanks	A	Calgary	Oct. 30	576	1,428.48	2.48
30	do	A	Lincoln	do	576	1,422.72	2.47
Nov. 16	Lindsay	K	Omaha	Nov. 16	244	602.68	2.47
16	do	K	New Orleans	do	244	607.56	2.49
17	do	K	Waco	Nov. 17	244	602.68	2.47
17	do	K	El Paso	do	244	597.80	2.45
17	do	K	Austin	do	244	602.68	2.47
19	do	K	San Antonio	Nov. 19	244	602.68	2.47
23	do	K	Lincoln	Nov. 23	244	663.68	2.72
27	do	K	Austin	Nov. 27	93	227.85	2.45

In addition to the above lots of Emperor grapes, 2,117 drums of Malaga and Cornichon grapes were sent to New York from Sultana, 1,833 by shipper L and 284 by shipper M. The results of these sales are shown in Table XIII.

TABLE XIII.—*Record of shipments of Malaga and Cornichon grapes in drums, packed in redwood sawdust and held in cold storage in New York, season 1912–13, showing gross receipts and average prices.*

Date of shipment.	Shipped from—	Number of packages.	Designation of shipper.	Date of sale.	Gross receipts.	Average price.
1912.						
Sept. 14	Sultana	749	L	Dec. 6	$1,090.18	$1.46
18	do	435	L	Nov. 14	467.90	1.08
18	do	213	M	do	262.20	1.23
21	do	649	L	Nov. 22	769.25	1.19
21	do	71	M	do	87.35	1.23
	Total or average	2,117			2,676.88	1.26

These cars were reported by the New York agent as arriving in generally poor condition, and an investigation was therefore made as to the conditions under which the fruit was picked and packed. It was found that the shippers, while appreciating the importance of having the fruit and sawdust dry, had overlooked the fact that prompt cooling is equally essential in preparing fruit for storage. As a result the drums and sawdust were taken into the vineyards and the grapes picked and packed between 10 a. m. and 6 p. m., when the temperature ranged from 95° to 100° F. in the shade. The grapes and sawdust were dry enough, but they were also well heated throughout, and when the warm fruit was placed in the drums the tight packages and the insulation provided by the sawdust held the heat for a considerable length of time and rapid deterioration resulted. Very poor prices were realized in New York, as the foregoing figures show.

It is not fair to base any conclusion as to the storage value of Malaga and Cornichon grapes as compared with Emperor grapes on the relative prices realized for the different lots during the past season. The varying conditions under which the different brands were prepared for market had much to do with the variation in the average prices received. The previous experiments of the Bureau (see Table IV) indicate that properly handled Malaga and Cornichon grapes should keep in good condition for at least two months. The low prices received for these varieties during 1912–13, after a holding period of two months, were probably caused by the presence of decay due to the manner in which the fruit was prepared for storage.

These details as to the prices received for the different lots are given in order to show the extremes. The range is no greater than is frequently the case in the lots of crate-packed grapes, due to the varying quality and condition of the fruit upon arrival in market. The average price obtained for the 19,834 drums sold during the season in the various markets enumerated above was $2.58 per drum.

The fruit buyers of the different cities to which small trial shipments were made showed great interest in the method of marketing California grapes packed in drums with a filler of redwood sawdust. The prices realized at the auction sales in these cities were equal to or higher than those which prevailed in the New York auction market, and this year's records indicate that a number of the smaller cities can handle at very satisfactory prices from one to four or five carloads of Emperor grapes packed in drums. Buyers have sent in very favorable reports from all the places where these grapes were offered for sale, and it was impossible to meet their demands this year with the shipments which were sent out from Chicago and New York. The best policy would seem to be to store carloads of the fruit at a number of points between Chicago and New York in the northern territory in order to meet the local demands. It is probable also that less trouble will be experienced in obtaining storage room in the smaller cities than would be the case if an attempt were made to store a large quantity of fruit in Chicago or New York. The different brands should be kept separate in storage and accurate records maintained of each lot, so that withdrawals may be readily made. Failure to follow this plan during the season of 1912–13 caused much confusion in making deliveries to buyers and also greatly increased the expense of handling the drums in the storage warehouses.

COST OF THE DRUM-SAWDUST PACK.

The cost of packing the grapes in drums with a filler of redwood sawdust, as determined by one of the leading shippers during the season of 1912–13, was as follows:

Drum	$0.33
Sawdust	.20
Packing and hauling	.20
Loading	.03
Total f. o. b. cost	.76
Freight	.57
Refrigeration in transit	.15
Total cost at eastern market	1.48

The freight charge is based on a rate of $1.15 per hundred pounds to New York, figuring the drums at 50 pounds gross weight, although in some places they were listed at a lower average weight. The cost of refrigeration is based on a charge of $90 per carload of 600 drums. Storage charges in New York and Jersey City during 1912–13 were 10 cents per drum per month, but it is reported that this rate will be increased next season. The commission charges at New York were 7 per cent of the selling price. Therefore, when grapes were held two months in storage the cost laid down at the auction sale, as estimated above, was $1.68 per drum.

On a basis of 35 pounds of grapes per drum, an auction price of $3 yields a net price of 3.17 cents per pound, or $63.40 per ton. A price of $2.80 per drum yields 2.63 cents per pound, or $52.60 per ton.

It is safe to assume that the cost of the sawdust and of the drums will be reduced when the demand increases sufficiently to warrant the manufacture of the packages in large quantities and the preparation of the sawdust on a large scale.

CONCLUSION.

The prices obtained during the season of 1912–13 for California grapes packed in redwood sawdust may be considered as very satisfactory on the whole. Owing to unusual weather conditions during the latter part of the packing season Emperor grapes were held on the vines exceptionally late and the fruit packed in crates reached the eastern markets in unusually fine shape until late in December. The sawdust-packed fruit in drums was compelled to meet competition from the crate stock in a way that will not be experienced in normal seasons. In addition, the sales of the Emperor grapes packed in cork, as previously noted, had a demoralizing effect on the sales of the fruit properly packed in sawdust. The cork-packed grapes were sold in the principal eastern markets before the sawdust-packed lots reached there. Many buyers of the cork-packed stock handled the fruit at a loss and therefore became suspicious of all California grapes packed in drums. Small lots of Emperor grapes packed in redwood sawdust were offered at the auction sales from day to day, however, and as they were found to be in sound condition the demand for them gradually increased, as is shown by the higher prices realized toward the end of the season. Very few complaints were heard from buyers who handled the sawdust-packed fruit. While the failure of the attempt to pack the Emperor grapes in cork caused considerable criticism and financial loss, the experience was valuable in that it emphasizes the importance of using proper care in packing and shipping as well as the necessity of selecting only the best stock for this rather expensive method of marketing.

The commercial demonstrations during 1911–12 and 1912–13, as well as the records of the Bureau investigations during the past seven years, show that the method of packing California table grapes with a filler of redwood sawdust and of holding them in cold storage for the holiday market is destined to form one of the successful practices of the grape industry of the State. Thus far the Emperor is the most acceptable variety for this purpose now being produced in California. A study of the methods of cultivating and training the Spanish varieties with a view to producing them on a commercial scale is well worth the efforts of both the Federal authorities and the State station investigators.

It is not expected that the sawdust-drum pack will replace the crate package for ordinary commercial shipments to any considerable extent. As has been shown, this system of handling is expensive and will therefore prove profitable only for the best grades of fruit, which can be marketed at comparatively high prices. The use of the sawdust-drum pack for commercial shipments to distant markets requiring long periods of transit or for shipments to central markets, there to be broken up and distributed to local points, is not only feasible but offers a means of reaching markets at present inaccessible, and renders possible the shipment of varieties possessing fine qualities but unadapted to shipment in crates without a filler.

The establishment of the sawdust-drum pack for California grapes has not been accomplished without opposition. It is a well-known fact that the trade always looks with disfavor upon any change in the established system of packing and handling fruit, and the use of the sawdust filler was no exception to this general rule. It required considerable effort on the part of the Bureau investigators and no little courage on the part of the pioneer commercial shippers to inaugurate this plan. Fortunately, the first commercial demonstrations were sufficiently successful to warrant a continuation of the efforts to market the fruit in this way on a scale large enough to establish the sawdust pack as a commercial practice. Great credit it due the growers and shippers who made possible the first commercial demonstrations, for without their cooperation the work would have lacked that most important final test necessary to make it of direct value to the table-grape industry of California.

The following principles summarize the recommendations of the Bureau of Plant Industry with regard to the storage of California table grapes:

(1) Only fruit of the best quality, which can be marketed at comparatively high prices, should be handled in this way.

(2) Those varieties of grapes which have open bunches are most suitable for packing in redwood sawdust.

(3) The drum barrel has been found to be the most satisfactory package for grapes packed in redwood sawdust.

(4) The redwood sawdust should be pure and unmixed with other woods and the particles should be of the size illustrated in Plate III, figures 1 and 2. Enough filling material should be used to prevent settling.

(5) The fruit should be cooled overnight in the vineyard or precooled before the packages are loaded into the cars.

(6) The fruit should be very carefully handled, the berries should be free from blemishes, and all imperfections should be removed.

(7) There should be a uniform quantity and quality of fruit in each package. The fruit should be culled before it is conveyed to the packers and should be graded for color and size of bunches.

(8) It should be shipped under refrigeration and placed in cold storage at 32° F. immediately upon reaching its destination.

(9) When these conditions have been observed, Emperor grapes may be held in cold storage until about January 10, the Malaga variety until December 15, and the Muscat until November 15. When Almeria grapes can be grown successfully for commercial purposes they may be held in cold storage until about April 1.

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1913

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Studies of primary cotton market
conditions in Oklahoma